

## APPLICATION-ORIENTED SPATIAL GRAPH GRAMMARS

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**Abstract:** *The Reserved Graph Grammar (RGG) is a general graph grammar formalism that expresses a wide range of visual languages. This paper presents an extension to RGG with the capability of spatial specification. Graph transformation satisfying the spatial specification can be performed in the process of parsing. The RGG with spatial specification can be applied to various types of applications. The paper demonstrates an example for mathematical expression recognition.*

**Key Words:** visual languages, spatial specifications, graph grammar, pattern recognition

### 1. Introduction

Motivated by the theoretical support for pattern recognition, compiler construction, and data type description, graph grammars originated in the late 60s have stepped in a period with theoretically sound and well-established foundation [1]. Graph grammars provide a natural approach to describing complex structures graphically. Moreover, graph transformation can be viewed as a model to present a dynamical evolution starting from an initial graph. So, the number of applications interacting with graphs has increased dramatically. There are already many well-known graph formalisms, such as Petri nets, Statecharts, flowcharts, and UML diagrams.

Compared to text, a graph can visually convey relationships and naturally represent structural information. With well-established theoretical foundation, graph grammars are powerful syntax formalisms to define logic relations among constructs of a graph. It, however, does not usually specify how those constructs look like. In many applications, spatial information plays an important role. For example, in graph layout, a graph grammar introduces a formal framework to generate a syntax-directed layout, which captures the internal structure of a graph. In multimedia design, the approach based on graph grammars provides the power of design validation and automatic presentation. Also, graphs are intuitive to present the logic and spatial relation among objects and graph transformation techniques have been applied to symbol recognition. We argue that a mechanism in the grammar for the designer to explicitly specify the physical layout for a graph apart from the internal structure is extremely useful for a wide range of applications.

*Reserved Graph Grammar* [2][3] is one of the context-sensitive graph grammar formalisms. Because of its

context-sensitive with a parsing complexity of polynomial time [4], RGGs can be applied to many applications. Though the RGG formalism provides a powerful approach to specifying internal structures, it ignores the spatial relations. This paper presents an extension to RGGs with the capability of spatial specification and applies it to mathematical expression recognition.

Section 2 introduces graph transformation and Reserved Graph Grammars. Section 3 defines *spatial relations*. Section 4 gives an example. Section 5 discusses related work, followed by the conclusion in Section 6.

### 2. Graph Transformation

For textual languages, there exist some general grammar formalisms such as context-free grammars and application tools such as YACC. Defining a general and expressive graph grammar formalism with an efficient parsing algorithm, however, has been an obstacle in the applications of visual languages. Even for the most restricted classes of graph grammars, the membership problem in the parsing process is NP-hard [5]. Consequently, a parser may not recognize a syntactically correct graph or be inefficient in analyzing a large and complex graph.

Another obstacle in restricting applications of graph grammars is that most proposed parsing algorithms [6][7][8] are context-free, while many interesting graphs cannot be specified by pure context-free grammars. Additional control mechanisms are necessary to provide context-sensitivity. It is, therefore, hard to apply context-free graph grammars to some applications, where the logic structure of a graph is too complex to define without context information.

A graph grammar is made up of a set of rewriting rules called *productions*. One production consists of two sub-graphs, called *left graph* and *right graph*. A graph transformation is a sequence of applications of productions. Applications are classified into L-application and R-application. An *L-application/R-application* is to replace a sub-graph in the host graph, which is isomorphic to the left/right sub-graph of a production (commonly called *match*), with the right/left sub-graph of a production. In other words, rewriting a graph *h* into a graph *h'* is to replace a sub-graph *m* in *h* by another graph of *d* and to embed *d* into the remainder of *h*. Different graph grammars employ different embedding approaches

[9]. The most difficult issue in graph transformations is to decide which matches are allowed and which are not.

The *Reserved Graph Grammar (RGG)* [3] is a context-sensitive graph grammar formalism with a parsing complexity of polynomial time. It provides a powerful mechanism to represent structures graphically and to perform automatic syntax validation through the automatically generated parser. Compared to context-free grammars, a *RGG* is more intuitive in defining syntax because of its context-sensitive property.

Since *RGGs* require a format that is suitable for the grammar, a host graph is first translated into the format, called a *node-edge form*. The translation is quite straightforward. Each node in the node-edge form is organized into a two-level hierarchy. A large rectangle is the first level called a *super-vertex* with embedded small rectangles as the second level called *vertices*. Each vertex is labeled by a unique character.

*RGG* employs a *marking* technique to solve the embedding problem and to avoid ambiguities. If a super-vertex or a vertex is marked, it will reserve its outgoing edges connected to vertices outside the replaced sub-graph in the application of a production. On the contrary, if a super-vertex or a vertex is not marked, the replaced sub-graph must contain all of the edges connected to this un-marked vertex. Otherwise, the so-called *dangling condition* [10], which is not allowed in *RGG*, will occur. Therefore, the marking technique is useful in distinguishing the context and eliminating *dangling conditions*.

The process of parsing a graph can be viewed as: select a production from the grammar and apply a R-application to the host graph. This process is continued until no production can be applied. If the host graph is eventually transformed into an initial graph (i.e.  $\lambda$ ), the parsing process is successful and the host graph is considered to belong to the language defined by the graph grammar. One of the difficulties in the process of parsing is to select an appropriate production when multiple choices exist, i.e. how to process ambiguities during parsing. The selection outcome will affect the parsing efficiency and final result, since if the current path fails, we must track back to test other paths, which costs computational time. *RGGs* use a deterministic parsing algorithm, called *selection-free parsing algorithm (SFPA)*, which only tries one parsing path [3]. Zhang *et al.* proves that the time complexity of SFPA is polynomial [4][11].

### 3. Spatial Relations

Spatial relations specify the geometrical relationships among graph nodes. We classify the specifications into four categories: *Length*, *Direction*, *Alignment* and *Size specifications*.

*Length specification* defines the distance among graph nodes. This type of specifications is introduced by the fact that if two nodes are close/remote semantically, they should be placed tightly/loosely in the graph. It consists of three relations: *Close*, *Remote* and *Spring*.

*Direction specification* expresses the direction information among nodes, such as left-to, above-of etc. Such information plays an important role in applications such as graph layout, mathematical expression recognition etc. Direction relations are transitive. For example, if node *A* is left-to node *B* and node *B* is left-to node *C*, we can induce that node *A* must be left-to node *C*. We can set up a *partial order* deduced from direction relations among nodes. The partial order, through which we can distinguish two nodes' relative positions, provides a global view of a graph. Based on the partial order, we can perform a spatial reasoning over the host graph.

*Alignment specification* addresses a special relation between two nodes along *X*-axis or *Y*-axis. Two nodes hold an alignment relationship if they are projected to *X*-axis or *Y*-axis, and the starting, ending or central points of the nodes are mapped to a same point on *X*-axis or *Y*-axis.

*Size specification* is used to indicate the size of a node, which can have practical meanings in applications. For example, we may use a node with large size to represent large data processing capability. *Size specifications* are defined by three measurements: *large*, *medium* and *small*.

#### 3.1 Length Specification

Motivated by the fact that the distance between two nodes in a graph can reflect their semantic relations, we define length relations among nodes. For example, if two cities are located closely, the line connecting the two cities in a map should be short.

- *Close relation*

A *close relation* is represented by a line with an arrow labeled "*close*". Semantically, *close relation* means that the nodes are highly related; in layout, it means that the nodes should be placed as tightly as possible.

- *Remote Relation*

On the contrary to the *close relation*, a *remote relation* represented by a line with an arrow labeled "*remote*", means that two nodes are loosely related semantically and placed as far as possible when they are drawn.

- *Spring Relation*

A *spring relation* represented by a line with an arrow labeled "*spring*", indicates that the distance ranges from *close* to *remote relation*.

The above three relations as illustrated in the left portion of Figure 1 provide a way to specify the distance qualitatively. It, however, is not sufficient to describe complex graphs, where we need to identify the variation

of the spring relation. The above three relations will be refined by adding quantitative mechanism. We divide the distance into 11 scales indexed from 0 to 10. A distance index will be assigned to a length relation. Instead of reflecting the actual length to be displayed on the screen, the distance index provides a quantitative approach to defining length relation. Larger index denotes longer distance. So, “1” is assigned to close relation and “10” to remote relation. The spring relation can range from 2 to 9. “0” indicates that two nodes are touched.

It is undesirable for the user to design the *length* specifications without any system help. First, it is tedious to adjust the length manually; second, the length of manually produced lines cannot exactly reflect the scale of the distance index. We will develop an authoring tool to ease the design task. The user only needs to choose the distance index and the tool will automatically generate an appropriate line.

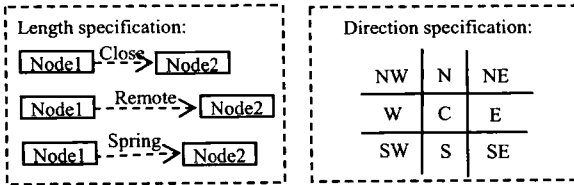


Figure 1 Length specification and direction specification

### 3.2 Direction Specification

We divide a planar into nine districts. In order to determine the direction relation between two nodes, one node is chosen as the *anchor* node, which is placed in the central district. There are eight possible directions for another node relative to the *anchor* node. Each of those directions is represented by a line labeled with N, W, S, E, NW, NE, SW or SE as illustrated in the right portion of Figure 1. If a node falls into more than one district and we identify its direction by the district where the main part of this node lies.

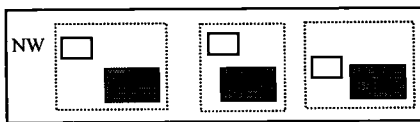


Figure 2 Sub-cases in NW direction

Obviously, the above eight direction relations are not sufficient to describe a complex graph. For example, if two nodes hold a *NW* relation, we need to differentiate that one node leans to *N* or *W* direction. Figure 2 lists three sub-cases of *NW* relation. The sub-cases for other seven directions are similarly defined. A specification tool for direction specifications can be easily implemented. The user first chooses one of eight directions, and three icons representing three relative sub-cases will be displayed. When the user clicks one of the icons, the

system will automatically adjust the layout and generate desirable relation.

### 3.3 Partial Order

*Direction* specification expresses the geometrical relation between two nodes, and is transitive among multiple nodes. For example, if  $n_1$  is left to  $n_2$  and  $n_2$  is left to  $n_3$ , we can conclude that  $n_1$  is left to  $n_3$ . We, therefore, can derive a geometrical order, which achieves a global view of relative positions among nodes in a graph.

#### • Partial order along Vertical Direction

We define  $n_1 <_{y \text{ direction}} n_2$  if and only if  $n_2$  has a *S*, *SE* or *SW* relation with  $n_1$ . The relation *POVD* (partial order in vertical direction) is defined as follows:

$$POVD = \{(n_1, n_2) \mid \text{if } n_1 <_{y \text{ direction}} n_2\} + \{(n, n) \mid n \in N\}$$

#### • Partial order along Horizontal Direction

We define  $n_1 <_{x \text{ direction}} n_2$  if and only if  $n_1$  has a *W*, *NW* or *SW* relation with  $n_2$ . The relation *POHD* (partial order in horizontal direction) is defined as follows:

$$POHD = \{(n_1, n_2) \mid \text{if } n_1 <_{x \text{ direction}} n_2\} + \{(n, n) \mid n \in N\}$$

Four special elements are defined as follows based on the partial order:

**Bottom**: The maximal element in the  $(V, POVD)$  is called *bottom* denoted by “ $\perp$ ”.

**Top**: The minimal element in the  $(V, POVD)$  is called *top* denoted by “ $\top$ ”.

**Left**: The minimal element in the  $(V, POHD)$  is called *left* denoted by “ $\mid$ ”.

**Right**: The maximal element in the  $(V, POHD)$  is called *right* denoted by “ $\mid$ ”.

### 3.4 Alignment Specification

If two nodes are projected to *X*-axis or *Y*-axis, and the starting, ending or central points of the nodes are mapped to the same point on *X*-axis or *Y*-axis, then we define that the two nodes have an *alignment* relation. *Alignment* relation along *Y*-axis is called *horizontal alignment*, and that along *X*-axis is called *vertical alignment*.

#### • Horizontal Alignment

In a graph, some nodes should be placed on a horizontal line. We define this relation as the *horizontal alignment* relation, represented by a line with an arrow labeled “*HA*”. If two nodes with the *HA* relation is of the same size, we can align either the upper-left point or the lower-left point. But if two nodes are of different sizes, we must explicitly specify how to align the two nodes. So, we divide *HA* relation into three sub-cases as illustrated in Figure 3: bottom alignment denoted by *HA-Bottom*, top alignment denoted by *HA-Top* and central alignment denoted by *HA-Cen*.

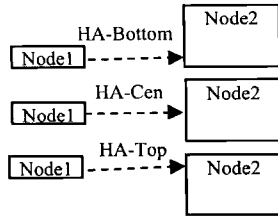


Figure 3 Horizontal alignment

#### • Vertical Alignment

Vertical alignment is similar to horizontal alignment except that it is along X-axis. Its three sub-cases are denoted by *VA-Left*, *VA-Right* and *VA-Cen*.

### 3.5 Size Specification

In a map, a large city is typically represented by a large circle and a small city by a small one. So, the size of a node may convey useful information and we introduce the size specification into the definition of the grammars. The size of one node can be classified into three categories: *large*, *medium* and *small*. A large node is represented by 10\*10 grids, and a small node by 1\*1 grids. A medium node ranges from *small* size to *large* size.

## 4. Mathematical Expression Recognition

The previous sections introduced the extended RGG with the capability of spatial specifications. This section presents the application of mathematical expression recognition to illustrate how to use the extended RGG.

In the electronic age, it is useful to convert paper document into an electronic form, which can be indexed, stored and retrieved in computers. Text can be recognized by Optical Character Recognition (OCR) [12]. But, a more sophisticated mechanism is required to recognize hand-written mathematical expressions, which has been researched for several decades [12].

A pattern recognition problem is often solved in the following three steps [13][14]. First, define a set of primitives and relations; second, recognize the primitives and build up relations among primitives over an input; third, interpret the input according to the recognized primitives and relations. Mathematical expression recognition is one of the pattern recognition problems. An approach based on PROGRES has been used to the mathematical expression recognition [14]. In this section, we will present how to recognize mathematical expressions based on the extended RGG.

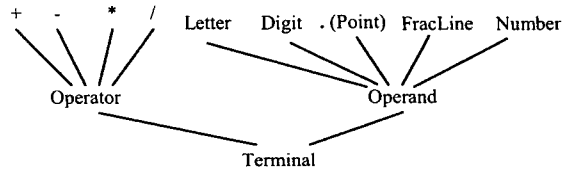


Figure 4 The terminal node scheme

A handwritten or typed mathematical expression is first scanned into an image. We use a node contained in a bounding box to represent each mathematical symbol. In

order to illustrate the process, we use a simplified expression. Totally, nine types of symbols organized in a hierarchy are defined in Figure 4. The root labeled as *Terminal* conveys general information, which can also represent its child nodes. On the other hand, a leaf conveys more specific information.

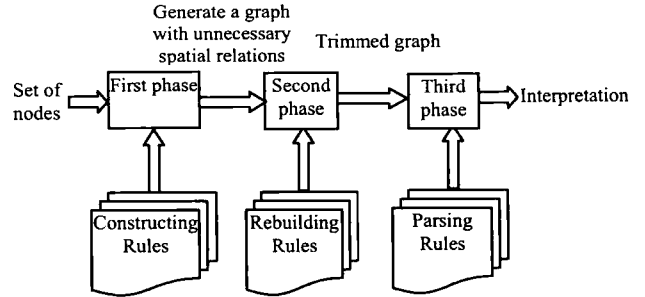


Figure 5 Phases in mathematical expression recognition

We will perform a graph transformation over the set of nodes through three phases as presented in Figure 5: constructing, rebuilding and parsing. In the first phase, four spatial relations among nodes will be built. A mathematical formula is often expressed in an irregular convention. For example, numbers may not be written along the same line, or not in the same size. Incorrect spatial relations may be introduced in the first phase. So, the host graph will be passed to the second phase to remove unnecessary spatial relations. At last, the trimmed graph will be interpreted by a parser.

**Constructing phase:** In this phase, four types of geometrical relations, left, above, superscript and subscript, are set up among nodes. Those four relations are defined as follows:

- **Left:** One node is left to the other node.
- **Above:** One node is above to the other node.
- **Superscript:** One node is located North-East to the other node.
- **Subscript:** One node is located South-East to the other node.

Figure 6 shows two of the productions in this phase. Through performing a calculation over the coordinates of the bounding box, we define several functions to test if one of the four spatial relations holds between the nodes.

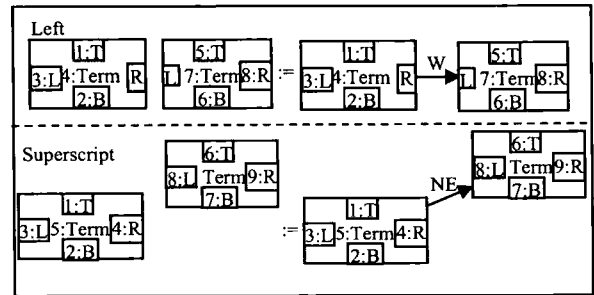


Figure 6 Two productions in the constructing phase

If the function proves true, a corresponding production will be applied to generate a spatial relation.

**Rebuilding phase:** Since a mathematical expression can be written in an irregular way, spatial relations may be built up incorrectly. Obviously, those errors will affect the final interpretation. So the purpose of the second phase is to eliminate noise-relations. For example, we need to delete any spatial relation across a fractional line, and combine two digits and a point into a number. The grammar rules for this phase and next phase are omitted due to the space limit.

Figure 7 A mathematical expression

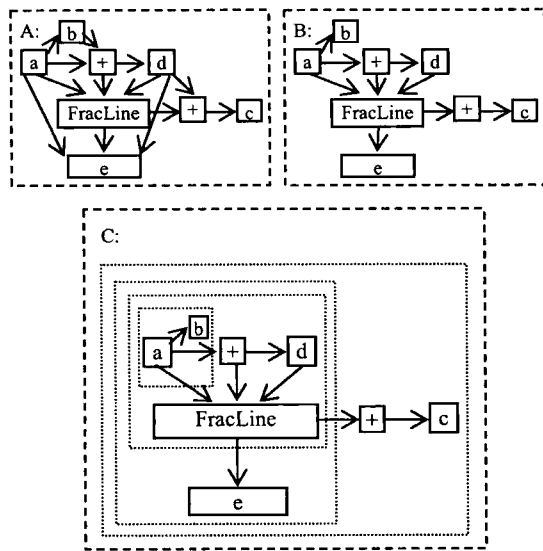


Figure 8 A recognition procedure

**Parsing phase:** When a graph is passed to the third phase, some unimportant and incorrect spatial relations introduced in the first phase have been eliminated. A parser will perform a syntactic analysis and interpretation.

For example, if we need to recognize the mathematical expression:  $(a^b + d) / e + c$  illustrated in Figure 7, Figure 8 illustrates the recognition procedure. Graph A presents the graph generated in the first phase. Obviously, some unnecessary spatial relations are created such as the spatial relation between  $a$  and  $e$ , and that between  $d$  and  $e$ . Graph B shows the result after eliminating noise relations. Graph C illustrates how to parse a graph passed from the second phase.

## 5. Related Work

Graphs are very suitable for describing objects with a complex structure in a direct and intuitive way, so graphs are a hot research field in computer science. Originated in 60s', graph grammars provide a formal approach to modeling the evolution of static graphs by the application of productions. Though the research in graph grammars has been conducted for decades, little work has been done on developing graph grammars supporting spatial relations explicitly. Drawing algorithms based on graph grammars (DAGG) [15], such as the algorithm in [16], introduced a formal approach to graph layout. Its central idea is to determine the node placement by an attribute evaluator. The spatial specification is addressed by the equation/in-equation between attributes which contain such information as co-ordinates. Since spatial relations are not represented visually, users may not catch the geometrical specification at the first glance. In order to complete layout in a polynomial time, DAGG uses a context-free graph grammar. Zhang *et al.* presented a layout algorithm based on RGGs [17]. This approach is used for graph layout. Its geometrical specification is limited to direction specification. We will compare the aforementioned approaches according to the following criteria as listed in Table1:

1. Underlying graph grammar
2. Application field
3. Complexity
4. Spatial relation representation

	Underlying graph grammar	Application field	Spatial relation representation	Complexity
DAGG [16]	Context-free	Layout	Equation/in-equation	Polynomial
Zhang <i>et al.</i> [17]	Context-sensitive	Layout	Graph	Polynomial
Our approach	Context-Sensitive	General purpose	Graph	Polynomial

Table 1 Comparison among graph grammars supporting spatial specification

## 6. Conclusion:

Spatial information is useful in many applications. In this paper, we have proposed to expand the RGG with the capability of spatial specification. We applied this spatial grammar to the applications of mathematical expression recognition.

Using a graph grammar based approach, we can benefit in the following aspects:

- **Visual:** Graph grammars provide a theoretical foundation for a visual approach to specifying the logic and spatial relations among the constructs of a graph.

- **Automatic:** A set of spatial constraints can be automatically deduced in the process of parsing from the spatial specifications embedded in the productions.

We plan our future work in the following two directions:

- **Enrich Spatial Relations:** Spatial relations extended in the RGG are far from complete. For example, topological relations are also an important aspect in spatial relations.
- **Embed Temporal Relations:** In addition to spatial specifications among media objects, temporal specifications offer another important dimension, which is useful in the design of multimedia documents.

## References:

- [1] G. Rozenberg (ed.), *Handbook on graph grammars and computing by graph transformation: Foundations*, Vol.1 (World Scientific, 1997).
- [2] D-Q. Zhang, and K. Zhang, Reserved graph grammar: A specification tool for diagrammatic VPLs, *Proc. VL'97-13th IEEE Symposium on Visual Languages*, Capri, Italy, 1997, 284-291.
- [3] D-Q. Zhang, Generation of visual programming languages (Ph.D. Thesis, Macquarie Univ., 1997).
- [4] D. Q. Zhang, K. Zhang, and J. Cao, A context-sensitive graph grammar formalism for the specification of visual languages, *The Computer Journal*, 44(3), 2001, 187-200.
- [5] G. Rozenberg and E. Welzl, Boundary NLC graph grammars – basic definitions, normal forms, and complexity, *Information and Control*, 69, 1986, 136-167.
- [6] E. J. Golin, *A method for the specification and parsing of visual languages* (Ph.D. Thesis, Brown Univ., 1991).
- [7] M. Kaul, Parsing of graphs in linear time, *Proc. 2nd Int. Workshop on Graph Grammars and Their Application to Computer Science*, LNCS 153, 1982, 206-218.
- [8] L. M. Wills, Automated program recognition by graph parsing (Ph.D. Thesis, MIT AI Lab, 1992).
- [9] A. Schurr, A. Winter, and A. Zundorf, Visual programming with graph rewriting systems, *Proc. 11th IEEE Symposium on VL*, 1995, 326-333.
- [10] J. Rekers, and A. Schurr, Defining and parsing visual languages with layered graph grammars, *Journal of Visual Languages and Computing*, 8(1), 1997, 27-55.
- [11] K. Zhang, D. Q. Zhang, and J. Cao, Design, construction and application of a generic visual language generation environment, *IEEE Trans. Software Engineering*, 27(4), 2001, 289-307.
- [12] D. Blostein, and A. Grbavec, Recognition of mathematical notation, *Handbook of Character Recognition and Document Image Analysis*, World Scientific, 1997, 557-582.
- [13] K.S. Fu, *Syntactic pattern recognition and applications* (Prentice Hall, 1982).
- [14] D. Blostein, and A. Schurr, Computing with graphs and graph transformation, *Software – Practice and Experience*, 29(3), 1999, 197-217.
- [15] Y. Kahn, and T. Baylis, A survey of graph drawing algorithm based on graph grammars, *Proc. Fifth Intl. Workshop on Graph Grammars and Their Application to Computer Science*, Williamsburg, Virginia, 1994.
- [16] F. Brandenburg, Designing graph drawing by layout graph grammar, *LNCS 894*, 1994, 416-428.
- [17] K. B. Zhang, K. Zhang, and M. A. Orgun, Grammar-based layout for a visual programming Language Generation System, *Proc. Diagram 2002*, Georgia, USA, 2002, 106-108.

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